THE DENTAL PRACTITIONER
AND DENTAL RECORD

Vol. VI, *No.* 9 — *May*, 1956

CONTENTS

PAGE

EDITORIAL: RESEARCH METHODS - - - - - - - - 273

THE USE OF HIGH-FREQUENCY CURRENT IN ROOT CANAL TREATMENT BY THE "JOULING" METHOD - - - *E. W. Kjaer, D.D.S. (Tandlaege)* 274

THE CLINICAL ASSESSMENT OF THE UNERUPTED MAXILLARY CANINE *D. T. Hartley, L.D.S., D.Orth. R.C.S.* - - - - - - 279

A CASE OF MARKED LOCALIZED GINGIVAL RECESSION - *J. R. Trott, B.D.S.* 288

THE CLINICAL ASPECTS AND PHYSIOLOGICAL MECHANISM OF ABNORMAL PATHS OF CLOSURE: PART II - - - *R. J. G. Grewcock and C. F. Ballard* 291

AUXILIARY SPRINGS FOR RETRACTION OF CANINES *E. K. Breakspear, L.D.S. R.C.S. (Eng.), D.Orth. R.C.S.* - - - - 297

BOOK REVIEW - - - - - - - - - - 290

LETTERS TO THE EDITOR - - - - - - - - - 299

NATIONAL HEALTH SERVICE NOTES - - - - - - - - 300

ABSTRACTS FROM OTHER JOURNALS - - - - - - - 296, 301

EXAMINATION RESULTS - - - - - - - - - - 302

SOCIETY NOTES - - - - - - - - - - 302

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THE DENTAL PRACTITIONER
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Vol. VI, No. 9 May, 1956

EDITORIAL

RESEARCH METHODS

In the main there are two principal aspects of research: pure research work in search of new knowledge by probing the secrets of nature, be it a living cell or an atom; and research to resolve a specific detail, with results that may be of immediate practical import to the technical world. Under certain circumstances these two aspects may overlap and one may lead to the other. They are, however, rarely performed by the same person, for each branch attracts a different type of mind, although there are exceptions, usually the geniuses of the world. It is the problem that attracts the mind and not the method of solution. Research cannot truly be divided into the theoretical and the practical, as these are inevitably closely linked together. One person is perfectly happy delving into the mysteries of histo-chemistry and looking down a microscope, highly practical research involving the theoretical aspects of dentistry. Another man must be given his material and will evolve a new technique for its clinical use; while a third will only be content designing and building new kinds of instruments.

One problem starts from scratch and has no apparent surface value save as an addition to our knowledge of living matter and requires considerable time and patience to complete. Another problem has an immediate beginning and an end in sight, although sometimes the end is not always the expected! These workers may all be the backroom boys of dentistry, but obviously some work nearer the front door than others, and the front door leads on to the street where the world and the profession take their daily constitutional. There is a need for both types of mind in dentistry, for our research is only at the dawn of knowledge. The problems of caries and periodontology are far from solution, and new materials open a whole vista of problems. The investigation into research in this country by the B.D.A. is to be applauded and the results will be awaited with interest. So, too, is the recent appointment of an American to work in this country on the correlation of research in the U.K. and the U.S.A. This interest in problems of dental research will undoubtedly give a spur to greater efforts to the benefit of future generations.

DENTAL MEETINGS IN MAY

18th Spanish Odontological Congress, Palma de Mallorca, May 5–12; 9th World Health Assembly, Geneva, May 8–26; 2nd Meeting Spanish Society of Orthodontists, Madrid, May 16–20; Segundas Tornadus Federación Odontológia Argentina, Santa Fé, May 27–30; 44th Annual Meeting F.D.I. and S.S.O. Congress, Zürich, May 29–June 3.

THE USE OF HIGH-FREQUENCY CURRENT IN ROOT CANAL TREATMENT BY THE "JOULING" METHOD

By **E. W. KJAER**, D.D.S. (Tandlaege)

THE purpose of this paper is to present a report on the use of the "Joulisator" and "Joulemeter" in the treatment of root canals with high-frequency current.

Briefly, the method of treatment is as described below.

METHOD OF TREATMENT

The effect of Jouling depends upon the fact that the drugs used are more active at higher temperatures. Professor Flohr of Berlin (1930) has shown that the effect of the medicaments used is doubled if the temperature is raised by 18° F. above the normal temperature. Similar results have been obtained by Dr. Prader of Davos (Prader, 1947).

After mechanical preparation and thorough cleansing of the canal, the procedure is as follows:—

1. A wisp of sterile cotton-wool on a plain broach is moistened with 3 per cent hydrogen peroxide and inserted in the root canal. The Joulisator is placed in contact with the broach with the switch on mark "Joule" until the hydrogen peroxide foams. The finger is kept on the heat indicator throughout to ensure that the canal is not overheated. This process is repeated until the peroxide no longer foams.

2. The canal is then washed out with absolute alcohol and dried with cotton-wool. The Joulemeter is then used to ascertain that the canal is dry. The lamp in the handpiece will not light when the canal is dry.

3. When the canal is dry, a wisp of cotton-wool is moistened with 2 per cent chloramine and inserted in the canal. The Joulisator is used as before, the application being repeated two or three times at intervals of 15 seconds. During this process, free chlorine is liberated.

4. The length of the canal is measured by inserting a broach and advancing it to the apex, the Joulemeter being placed against the broach. When the point reaches the apical foramen, the bulb lights up. The length of the canal can thus be accurately measured.

5. In the case of a periapical granuloma, the apex is penetrated to a distance of 1 mm. Heat is applied five times, the temperature not exceeding 160° F. indicated by the Joulemeter.

6. In most cases the root filling can be completed at the same visit, as coagulation of the apical foramen enables the canal to be kept dry.

COMMENT

Dentistry is mainly an empirical science and experience proves that the above-mentioned system of root-canal treatment will give good results if the technique is followed in its entirety, namely coagulation, heating, root measuring, which produces a short coagulation of the apical foramen, and immediate root filling.

1. Extirpation of the vital pulp by coagulation, thus avoiding hæmorrhage.

2. Sterilization of the canal with heated drugs. This is done before widening of the apical foramen or the full effect will not be produced.

3. Coagulation of the pulpal vessels at the apex and measurement of the root canal. This enables the root treatment and root filling to be completed in one visit.

RESULTS

The method has been proved in the following ways:—(1) 623 radiographic controls; (2) Bacteriological investigations have been carried out in 232 cases; (3) Of these cases 14 have been examined histologically; (4) A further twenty teeth have been the subject of experiments with radio-active chlorine in which the

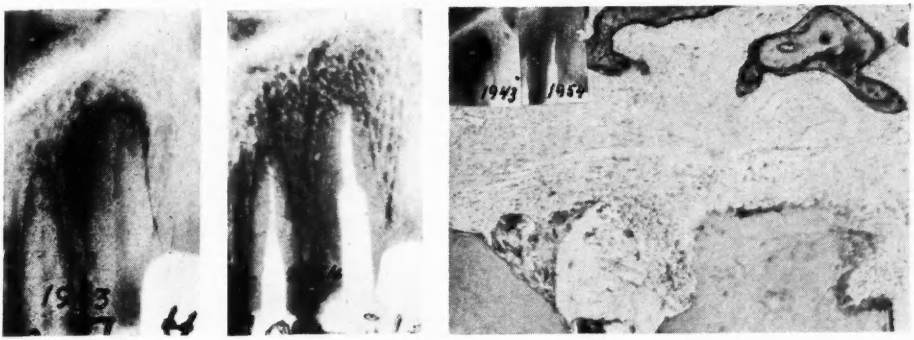
Geiger counter and radio-autographs have been used.

1. The 623 cases treated by high-frequency current under radiographic control were treated over a period from 1927 to 1954. Over the whole period, 92·1 per cent of these cases were considered to be satisfactory clinically and radiographically. From 1951, when the Joulemeter was first used, the percentage of cases showing good results rose to 96 per cent, which corresponds with the bacteriological results in Group II beneath.

Table I summarizes the results of radiographs.

2. *Bacteriological Investigation.*—

a. Group I. Consisting of 25 teeth, all giving positive on culture. After one treatment with 3 per cent hydrogen peroxide followed by 2 per cent chloramine, but without jouling, 23 were still positive. (8 per cent sterility.)



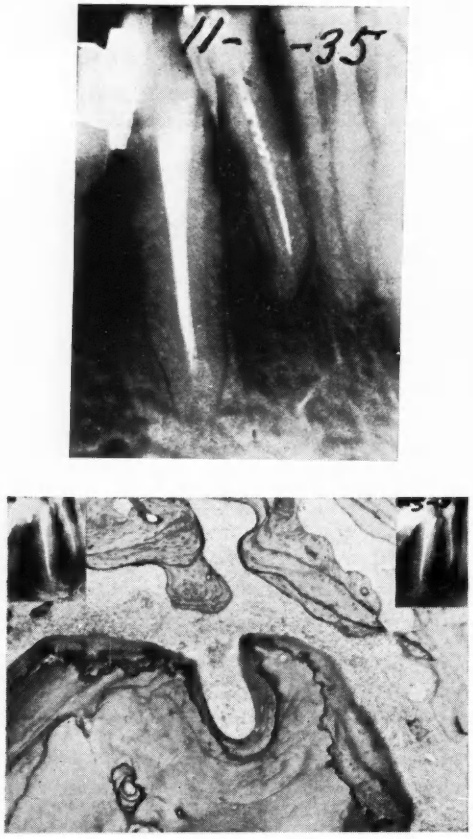
A B C

Fig. 1.—A shows a very large abscess extending halfway down the root mesially and a quarter of the way. B shows nearly perfect regeneration of the bone-tissue, and the periodontal membrane can be seen all the way round; there seems only to be a small split-formed abscess close to the apex. This apex was removed to investigate why this abscess did not heal. C is a microphotograph of a histological preparation. The periodontal membrane is normal. The surrounding bone in the medullary cavity nearest apex is not inflamed. The distant medullary cavity holds normal fat-marrow. In the alveolar bone you can see distinct apposition processes.

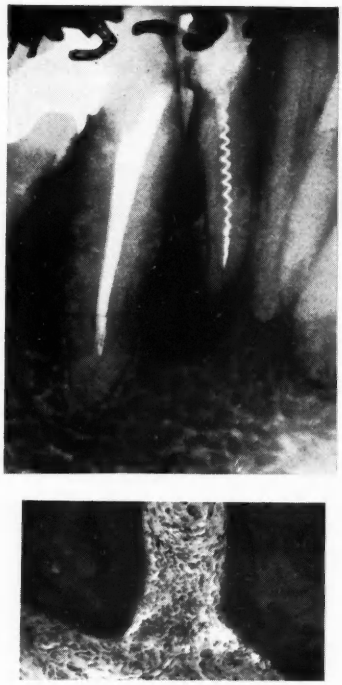
Table I.—Results of Radiography

Period 1927–54	Results				Percentage Complete Healing
	Good	Doubtful	Bad	Total	
Total root fillings	588	20	15	623	94·4
Root fillings to apex	367	11	10	388	94·5
Root fillings not reaching the apex	221	9	5	235	94·2
Root treated before 1951	377	16	13	406	92·1
Root treated with Joulemeter 1951–54	211	4	2	217	97·0

b. Group II. Consisting of 81 teeth, all showing growth, which were treated with 3 per cent hydrogen peroxide and 2 per cent chloramine together with jouling and apical



A



B

Fig. 2.—Jouled 18 years before apical amputation. A is a view of the apex with surrounding tissue. B is an enlargement of apical foramen. In the otherwise normally structured membrane you can see a few round-cells. Notice the apposition processes in both tooth and alveolar bone.

coagulation. On culture 78 cases gave negative reports. (96 per cent sterility.)

c. Group III. The root fillings of 20 cases were removed from one to eight weeks after jouling treatment and cultured in agar. All gave negative reports.

3. *Histological Investigations.*—Twenty of the cases were selected; the apices and a block of surrounding tissue were removed. These specimens proved to be suitable for histological preparation. Photomicrographs of two of the cases are shown in *Figs.* 1 and 2.

Case 1.—The radiographs show the condition before and after treatment and the portion of apex with attached periapical bone. $\underline{|3}$.

The periodontal membrane is seen to be normal. There is evidence of new bone deposition with normal marrow spaces. (*Fig.* 1.)

Case 2.—The $\overline{3|}$ jouled 18 years before apical amputation. *Fig.* 2 A is a view of the apex with surrounding tissue. *Fig.* 2 B is an enlargement of the apical foramen. A few round cells can be seen, but otherwise the membrane structure is normal. Apposition processes can be seen on both tooth and alveolar bone with normal apical surroundings.

The bacteriological investigations have proved that it cannot be the chloramine alone that is active. The effect may be partly explained if chlorine is given off by the action of the current. This fact can be established by the use of the chlorine indicator orthotolidin,

and the diffusion of the free chlorine into the dentine can be established by the Redox method.

canal. The reading in microvolts is used to indicate that free chlorine has diffused through the dentine. (*Fig.* 3.)

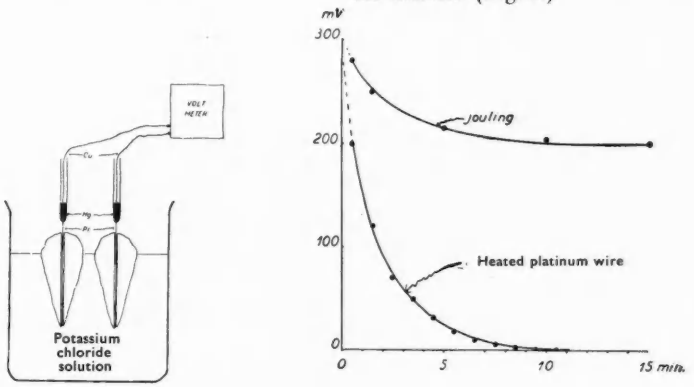


Fig. 3.—The illustration shows the method and the graph indicates that after passing the high-frequency current the microvolt reading is retained for 24 hours, whereas when a heated platinum wire is inserted into the root canal the current falls to zero in 10 minutes. The curve shows that chlorine stays longer in the dentine when heated with high-frequency current than with red-hot platinum needle.

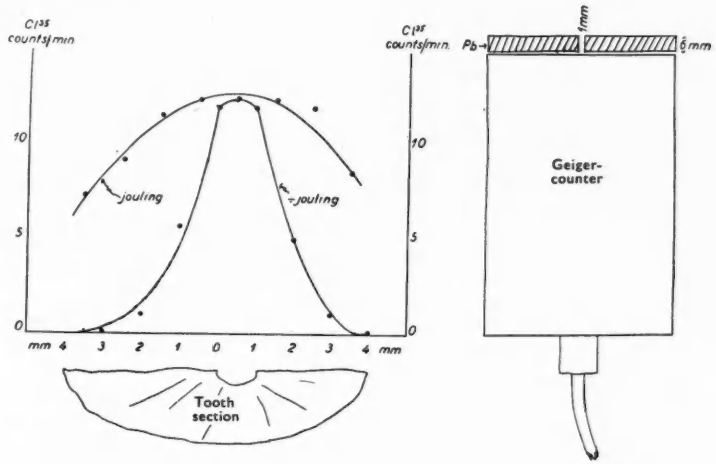
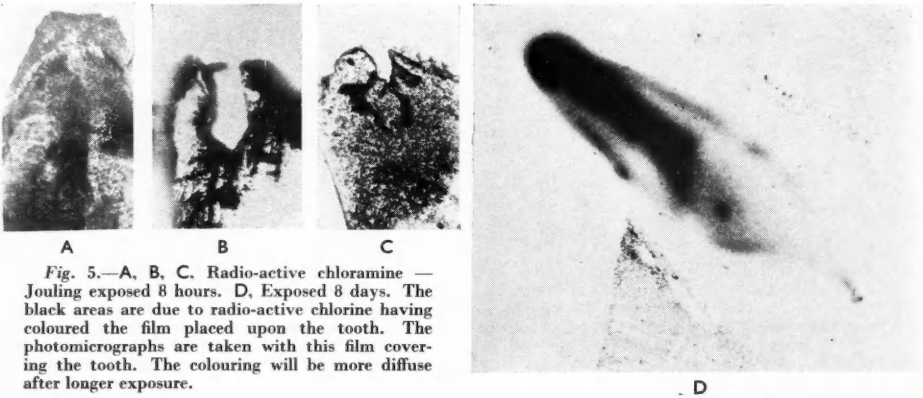


Fig. 4.—Graph I shows the distribution of Cl 35 in a tooth which has been treated by jouling and with marked chloramine compared with a tooth treated with marked chloramine but without jouling.

This is a method whereby the diffusion of Cl ions into dentine can be demonstrated by immersion of the tooth in a solution of potassium chloride. High-frequency current is passed through a platinum electrode in the root

4. An investigation into the length of time the chlorine stays in the dentine and where it is deposited by the use of radio-active chlorine has been undertaken. The experimental series consisted of 20 teeth treated *in vitro*, half being

treated with radio-active chlorine by jouling, the remainder with radio-active chlorine, but without jouling. All the teeth were examined with the Geiger counter immediately after treatment and then after an interval of one month. The teeth that had been jouled gave



A B C D

Fig. 5.—A, B, C. Radio-active chloramine — Jouling exposed 8 hours. D, Exposed 8 days. The black areas are due to radio-active chlorine having coloured the film placed upon the tooth. The photomicrographs are taken with this film covering the tooth. The colouring will be more diffuse after longer exposure.

two or three times as many counts as those that had not. Some of the teeth were examined by the Geiger counter to show the distribution of the chlorine.

The curves show the results obtained and the illustration shows the Geiger counter with a 1-mm. slit in the lead shield used to measure the local radio-activity. The teeth were passed over the slit with a millimetre screw.

In *Fig.* 4 graph I shows the distribution of Cl 35 in a tooth which has been treated by jouling and with marked chloramine compared with a tooth treated with marked chloramine but without jouling.

Some ground sections were prepared from which the radio-autographs above were produced. (*Fig.* 5.)

SUMMARY

The purpose of this paper has been to show that:—

1. The method is useful in disinfecting the root canal as confirmed by bacteriological tests.

2. The slight coagulation does not seem to injure the bone and the periodontal membrane of the root, as is shown by the photomicrographs of the histological sections.

3. The healing of the resorption caused by the inflammation is accomplished, confirmed by X-ray controls and histological results.

4. Chlorine deposits in the apical delta and the foramen and may thus prevent a recurrence. This is demonstrated by the radio-autographs of teeth treated *in vitro* with the radio-active isotope Chlorine 35.

5. Root treatment and root filling can be done in one consultation.

6. The length of the root filling does not affect the result when jouling is used.

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THE CLINICAL ASSESSMENT OF THE UNERUPTED MAXILLARY CANINE*

By **D. T. HARTLEY**, L.D.S., D.Orth. R.C.S.
Turner Dental School, Manchester

THE maxillary permanent canine normally erupts between the ages of eleven and twelve years. For a year or two before its eruption the thin bony covering of its crypt forms a slight bulge on the labial surface of the alveolar process above the deciduous canine, and can be detected, high up towards the sulcus, by digital palpation.

Fig. 1.—Normal unerupted canine ($11\frac{1}{2}$ years).

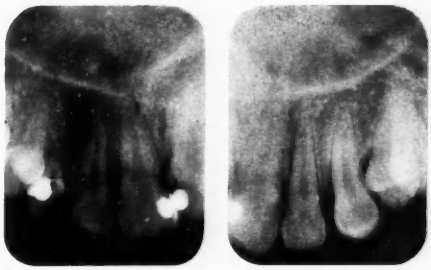

Fig. 2.—Congenital absence of $\underline{3}|$, normal eruption of $|\underline{3}$ ($12\frac{3}{4}$ years).

At this stage, routine radiographic examination produces a periapical film such as *Fig.* 1. Resorption of the root of the deciduous canine is occurring ahead of the permanent crown. The root of the permanent tooth shows a considerable degree of development, which is normally complete by thirteen to fourteen years of age, i.e., within one to two years of its eruption, the fairly complete development of the root by the time of eruption being a notable feature of the permanent canine. The long axis of the tooth has a moderate amount of mesial inclination of the crown, but the general line conforms to that of the adjacent lateral and first premolar teeth.

Diagnosis.—At variance with this picture of the normal unerupted canine are the circumstances when the unerupted tooth is displaced. This condition may be disclosed: (*a*) During routine radiographic examination of the mixed dentition; (*b*) When retention of a deciduous canine beyond the age of thirteen years is investigated; (*c*) During investigation of the absence of the canine from the permanent dental arch of an adolescent or adult patient, with no definite history of its extraction.

It may be noted here that it is extremely rare for the canine to be congenitally absent. *Fig.* 2 illustrates this infrequent condition; $\underline{3}|$ is absent, $\underline{C}|$ is retained but its root shows considerable resorption, while $|\underline{3}$ has erupted normally.

Frequency.—Although the upper canine is second only to the third molars in order of frequency of non-eruption and malposition, this condition is not encountered very often. Rohrer (1929) found it in 2 per cent of approximately 3000 patients radiographed. This frequency was quite well confirmed by Mead (1930) with a figure of 1·6 per cent in 1462 patients.

Type of Displacement.—Because of its developmental position within the maxilla and relative to the other teeth, demonstrated by Logan and Kronfeld (1933), malpositions of the canine most frequently consist of an inclination of its crown mesially and lingually. Rohrer noted this in roughly two-thirds of his cases.

* A Paper read at the Sheffield Meeting of the British Society for the Study of Orthodontics on May 6, 1955.

Since this particular type of displacement of the canine presents a well-defined clinical problem, this paper is limited to its study and is thus concerned with the maxillary permanent canine which is delayed in eruption and displaced into a lingual malposition.

Fig. 3.—Abnormal unerupted $\underline{3}|$: topographic occlusal film taken with X-ray tube in median plane (20 years; patient A).

Clinical Examination.—When displacement of the unerupted canine is suspected, palpation of the labial and lingual surfaces of the alveolar process often provides preliminary information.

Where the deciduous canine is present and the normal bulge of the outer alveolar plate over the crown of the permanent tooth cannot be detected, it is likely that the permanent crown is displaced lingually to some extent. The persistence of the more linear swelling produced by the bone covering the relatively unresorbed root of the deciduous tooth is additional evidence of abnormality.

Palpation lingually may disclose a bony swelling if the crown of the permanent canine is displaced in this direction and lies near the surface. The firmness and irregularity of the fibrous connective tissue of the palatine rugæ can make this examination deceptive.

Radiographic Examination.—Radiographic investigation is the next step. One exposure, usually of a periapical film, is made first, and from an examination of this the other views necessary are determined.

The radiographs must show: (*a*) The position of the crown of the canine relative to the adjacent teeth—vertically, mesiodistally, and labiolingually; (*b*) The position of its apex—vertically, mesiodistally, and labiolingually; (*c*) The direction of its long axis. Additional information, such as the degree of resorption

Fig. 4.—Abnormal unerupted $\underline{3}|$: periapical film (patient A).

of the root of the deciduous canine when present, will obviously be available from these films.

To fulfil these requirements radiographs taken from at least two different directions, approximately at right angles, are essential. The use of a single radiograph, giving a view from only one direction, frequently leads to failure to appreciate the true position of an unerupted canine.

A topographic (root length) occlusal film of the upper incisor region is often used, but alone it is relatively valueless. It is not uncommon to find the diagnosis of "horizontally unerupted canine" made from a single radiograph of this type such as *Fig.* 3, taken with the X-ray tube in the median plane. This diagnosis is quite unjustifiable—the true inclination of the long axis of the unerupted tooth cannot be judged; in addition, the mesiodistal position of the canine apex and the vertical relation of the crown to the incisor apices are distorted.

One, or sometimes two, periapical radiographs are usually sufficient to show accurately the mesiodistal and vertical positions of

crown and apex, and the inclination of the long axis in the vertical plane. *Fig.* 4 is a periapical film of the same patient from which the relation of the canine apex to the apex of the first premolar, and the vertical and mesiodistal relation of its crown to the root of the

Fig. 5.—Abnormal unerupted $\underline{3}|$: topographic occlusal film taken with X-ray tube in canine fossa (patient A).

lateral, can be judged. The resorption of the deciduous canine root can also be seen.

The more horizontal the canine is lying, the greater is the need for separate radiographs to cover its entire length with accuracy. In fact, Field and Ackerman (1935) writing on this particular problem considered it necessary to have three periapical views to obtain the fullest information.

A topographic occlusal film taken from the direction of the canine fossa provides a somewhat similar view over a wider field, but may be inaccurate in the vertical plane. *Fig.* 5 shows this view, and should be compared with the periapical radiograph of the same case (*Fig.* 4) and with the midline topographic occlusal film (*Fig.* 3).

The labiolingual relation of the unerupted canine is best determined by a cross-section occlusal film giving a plan view of the upper incisors. Only by this means can the closeness of the canine crown to the incisor roots, the buccolingual position of the apex, and the direction of the long axis, be accurately determined in the horizontal plane. Hitchin (1951) made some useful comments on the need in these cases for angulating the X-ray tube to obtain an end-on view of the incisors, rather than a general plan of the whole upper arch. *Fig.* 6, showing the cross-section view of the same case, also illustrates the difficulty which may be encountered in obtaining good definition of the teeth in an adult patient (this patient was aged 20 years) because of the

Fig. 6.—Abnormal unerupted $\underline{3}|$: cross-section occlusal film (patient A).

density of the considerable amount of bone through which the X rays have to pass when exposing this type of film. The radiograph shows the crown of the canine to be lying lingually to the lateral and central incisors, with its tip near the midline; the canine apex is in the line of the arch buccolingually.

When the more powerful X-ray equipment necessary for exposing a cross-section occlusal film is not available, and the labiolingual relation of the canine to the other teeth is in doubt, its position is determined with a standard dental X-ray unit by using the tube-shift or Clark localization technique. *Fig.* 7 shows the periapical radiographs produced by the application of this method to the case previously illustrated. The X-ray tube was moved a short distance mesially before the right-hand film was exposed. Noting the relation of the cusp of the canine to the roots of the lateral and central, it appears on

the right-hand film to have moved towards the midline, i.e., it has moved in the same direction as the tube. The crown of the canine therefore lies on the lingual side of the roots of the incisors.

Stereoradiographs are interesting but usually of less clinical value than the preceding

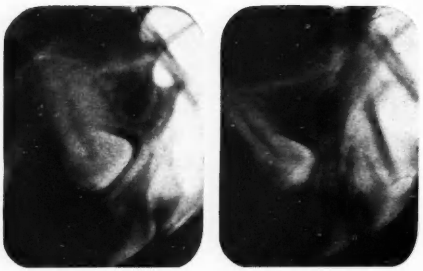

Fig. 7.—Abnormal unerupted $\underline{3}|$: labiolingual localization by tube-shift technique (patient A).

methods, and require special apparatus for viewing.

Assessment of Prognosis.—

1. *Position of Permanent Canine.*—The information derived from the radiographs is used to assess the prognosis for obtaining a satisfactory position of the canine within the arch.

The line of the long axis of the canine represents its potential path of eruption. Providing that this is directed towards the surface and not into other teeth, the canine crown will become accessible if full eruption occurs. Once full eruption has taken place a relatively simple orthodontic appliance pressing on the crown will produce tilting of the tooth. The fulcrum for a simple tipping movement is located near the apex, within the apical third of the root. The position of the apex after eruption of the canine thus determines whether or not the crown can be tipped into the arch.

It is therefore necessary that: (*a*) The potential path of eruption shall be directed towards the surface and be unobstructed by other teeth; (*b*) When eruption is complete the apex shall be near the normal position—vertically, mesiodistally, and labiolingually. This implies that the path of eruption must pass through the area occupied by the apex of the normally erupted canine.

The prognosis for the unerupted canine is most favourable when its position conforms exactly with these requirements. In the case shown in *Fig.* 8 the occlusal radiograph shows the crown of the canine to be well clear of the incisors, and not too close to the midline. The apex is in the line of the arch. The periapical view shows that the crown is not very deeply placed. The inclination of the long axis is favourable, being fairly upright, and there is an unobstructed path of eruption. The apex is so placed that eruption of the canine along its present axis will eventually position the apex normally between the lateral and the first premolar. The prognosis is therefore good.

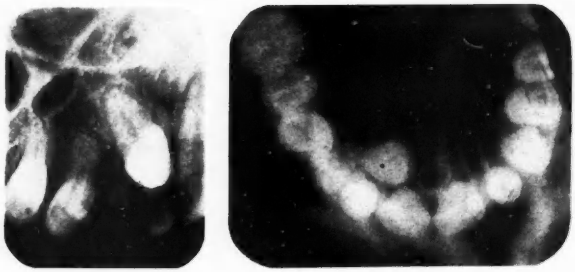

Fig. 8.—Abnormal unerupted $\underline{3}|$: good prognosis ($17\frac{1}{2}$ years).

The initial treatment required is limited solely to the surgical exposure necessary to provide a free path of eruption. The canine can then be left to erupt until its apex is approximately in the normal position, when simple tipping movement by an appliance will ensure its crown being positioned normally in

the arch. This is the type of case which is most likely to prove successful in the hands of the careful practitioner, and its detailed treatment has been adequately covered by Dewel (1945), Lappin (1951), and Fastlicht (1954).

Fig. 9 shows the original position of the unerupted canine in a case of this sort; the patient was aged 15 years. The prognosis is favourable as judged by the criteria suggested. Four months after extraction of the deciduous canine and surgical exposure of the permanent canine, the latter had erupted to the stage where labial tipping of the crown by an appliance was indicated. *Fig.* 10 shows the position after a further seven months, with the crown in place in the arch and the inclination of the tooth quite normal.

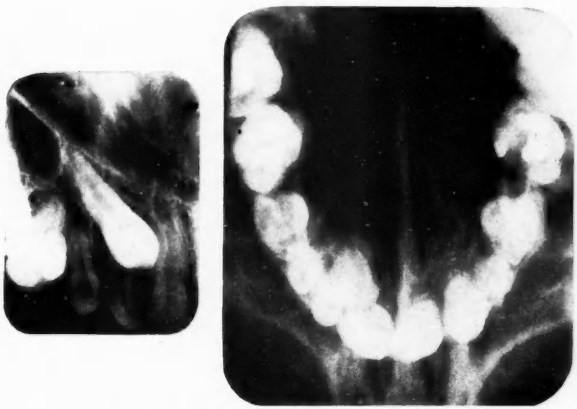

Fig. 9.—Abnormal unerupted 3| before treatment; good prognosis (15 years; patient B).

Fig. 10.—3| in arch, 11 months later (patient B).

Where the first requirement—an unobstructed path of eruption for the canine—can be achieved only by mechanical traction on its crown to tilt it away from adjacent teeth after surgical exposure, the prognosis is poorer. The appliance therapy required is likely to be lengthy and complicated, and attended by risk to the vitality of the tooth. This type of case is best left to the joint efforts of a competent oral surgeon and a skilled and experienced orthodontist. When the crown of the canine is very deeply buried, the limiting factor may well be the surgical, rather than the orthodontic, difficulty.

Fig. 11 is an example of a case with a doubtful prognosis. The crown of the canine is tucked in very close to the root of the lateral, and its long axis is nearer the horizontal than the vertical plane. It cannot reach the surface unaided, and mechanical traction on the crown will be needed to obtain a more favourable line for eruption.

The second requirement—a normal position of the apex finally—is invariable. If an obstructed path of eruption is to be changed by tilting the tooth as described, allowance must be made for this when assessing the original apical position on the radiographs. Although tilting the tooth will not in itself move the apex a great deal, it will change the direction of the long axis and hence the path taken by the apex as the tooth erupts. If it is estimated that a normal position of the apex cannot be obtained either with or without this mechanical treatment, then the prognosis is hopeless.

Fig. 12 shows a canine which lies horizontally and crosses from buccal to lingual of the arch. The apex lies distally and buccally to the root of the premolar, and at an abnormally low level. Orthodontic treatment for this canine is useless.

Support for the adequacy of these criteria is provided by the views of Erikson (1938), Dewel, and Lappin, who all stress the marked tendency towards voluntary eruption of the canine, without any mechanical traction, given a freedom from obstruction.

the canine conforming to the criteria I have proposed.

Watkin (1947) drew attention in a case report to the path taken by the apex of an upper canine during orthodontic treatment by an appliance, as did Marsh (1948). The

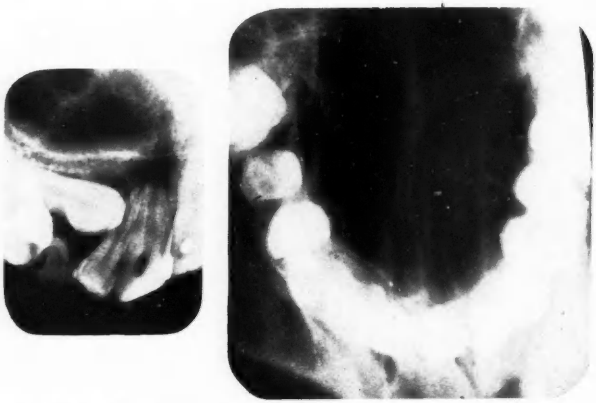

Fig. 11.—Abnormal unerupted $\underline{3}|$: doubtful prognosis ($15\frac{1}{2}$ years).

Fig. 12.—Abnormal unerupted $\underline{3}|$: hopeless prognosis (19 years).

Surprisingly, although the literature contains many case reports of malpositioned unerupted upper canines, the prognosis assessed prior to treatment is very seldom mentioned. It is perhaps significant, however, that an examination of the reproductions of radiographs accompanying the published successful cases almost invariably shows the position of

necessity of starting with a favourable position of the apex of the canine was mentioned by Day (1951). Both Watkin (1936) and Stones (1954) have referred to the importance of the inclination of the tooth when considering treatment. Apart from these I can find little or no reference to the matter—doubtless it is one which the skilled orthodontist

considers almost subconsciously when assessing a case.

2. *Resorption of Deciduous Canine.*—I have discussed at some length the influence of the position of the unerupted canine in determining the prognosis for treatment to utilize this tooth in the arch. Another factor operating in these cases is the amount of root resorption of the deciduous canine when this tooth is retained.

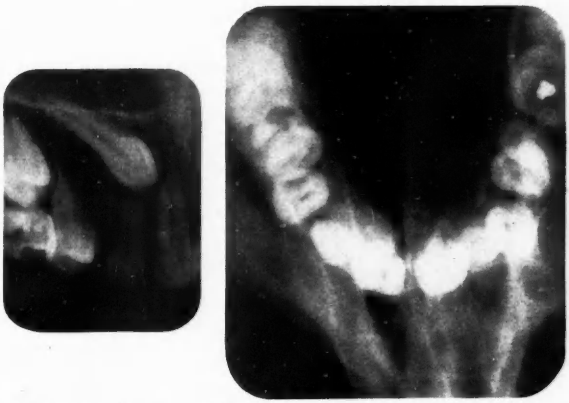

Fig. 13.—Abnormal unerupted $\underline{3}|$ in proximity to incomplete root of $\underline{2}|$ (11 years).

The retained deciduous canine is often relatively unresorbed, and the alternatives for treatment then are: (*a*) Extract the deciduous canine and move the permanent canine into position; (*b*) Retain the deciduous canine and extract the unerupted permanent canine; (*c*) Retain the deciduous canine and leave the unerupted permanent canine undisturbed.

The choice of the appropriate treatment in a particular case is outside the scope of this paper, but some of the implications may be considered.

A retained deciduous canine may remain functionally useful for many years, but not infrequently such a tooth is shed in the second or third decade of life. The eventual resorption of its root follows loss of the vitality of the cementum, which is then unable to repair the progressive resorptions produced by adult masticatory stress (Kronfeld, 1932; Aisenberg, 1941). An artificial replacement for the canine is then needed.

The decision whether or not to leave an unerupted misplaced canine in situ is governed particularly by the closeness of its relation to adjacent teeth. In later life it may start to move, and as its crown usually points mesially the root of the lateral or central incisor may be jeopardized, resorption being produced by pressure from the connective tissue follicle of the canine. Alternatively, the incisor may be pushed out of alinement.

Fig. 13 shows absence of the apical part of the root of the lateral incisor in a patient aged 11 years; the follicle of the unerupted canine lies over the blunted root end of the lateral. At this time the lateral gave a normal vital response to thermal stimuli, and there were no symptoms.

Occasionally an unerupted canine is responsible for referred pain of a neuralgic type—a number of such cases were reviewed by Nodine (1944), and Watkin (1947) described a case. In young patients there is a possibility of dentigerous cyst formation around the crown of an unerupted tooth.

Nevertheless, a completely unerupted canine may remain symptomless for very many years, and the possible complications resulting from its surgical removal might do more harm than good. Chapman (1949) reported a case where

an unerupted maxillary canine had produced no symptoms or damage to adjacent teeth in a man aged 75 years.

3. *Age of Patient.*—The age of the patient is a factor of some importance when treatment is contemplated to restore an unerupted misplaced canine to the arch. Following surgical exposure, a canine with an unobstructed path of eruption will erupt most rapidly and most completely where the surgery is carried out within a year or two of the normal eruption date. In an older patient, such as a young adult, the eruption of the canine is likely to be slower and less complete, necessitating a larger amount of mechanical therapy. This emphasizes the value of early recognition of the condition.

CONCLUSIONS

It will be seen that the assessment of prognosis for the unerupted misplaced maxillary canine can be made with a considerable degree of accuracy. It is based primarily on an adequate radiographic examination. Applying the criteria suggested and having regard to the other factors mentioned, logical reasoning will then indicate the appropriate line of treatment and its probable outcome.

A clearer understanding of what can, and what cannot, be done for buried canines should go far to ensure that patients are not subjected to extensive mechanical therapy unnecessarily, or unavailingly.

My thanks are due to the Department of Medical Illustration, United Manchester Hospitals, for production of the illustrations from the original radiographs, and to several of my colleagues at the Turner Dental School for helpful advice during the preparation of this paper.

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DISCUSSION

Mr. Kettle said he thought that an accurate estimation of the prognosis for the successful eruption of an upper canine into a satisfactory position was very difficult indeed. The most significant factor in determining the position of the unerupted tooth, when it was not presenting as a visible bulge and not palpable, was the position of the upper lateral incisor. He said it was difficult to assess by X rays alone whether the canine was lying palatally or buccally to the dental arch. Where the canine was lying buccally to the root of the lateral, the crown of the lateral was often tilted forwards and the apex of its root displaced inwards. Where the canine was on the palatal side of this tooth a retroclination of the crown of the lateral incisor was usually observed. The primary clinical examination should be followed up with stereoscopic X rays of the palate which do not necessarily require any complicated apparatus for their proper interpretation. He was not very happy in the cases shown by Mr. Hartley about the emphasis which had been laid upon treatment by simple surgical exposure and leaving the tooth to erupt unaided. He thought that this line of treatment would lead to quite a number of disappointments, because the canines are often impacted against the adjacent teeth and are not always able to erupt without assistance. Mechanical traction with an orthodontic appliance is often required or a zinc oxide pack must be inserted to prevent the healing of the palatal mucosa in the path of the eruption of the tooth. Dense bone tends to form around the crown of a canine which is disturbed by surgery and then left in an impacted position without further treatment.

Mr. Hovell said that he agreed with everything that Mr. Hartley had said about the position of the crown and apex of the upper canine. He thought its axial inclination had got to be studied. He thought there were one or two factors which ought to be brought out in the treatment of the palatally misplaced canine. He said he laid down certain criteria which had got to be followed during treatment. First you must make room for it in the dental arch. This could be done by closing up spaces in the incisor teeth or removing the first premolar. If the first premolar is extracted this often converts the bringing down of the canine to a much easier procedure. Secondly, the surgical exposure must be adequate; it is no good making a little hole in the palate, saying you have exposed it. Adequate bone removal should be made without damaging the adjacent teeth. Thirdly, it is essential in almost all cases to keep

the hole patent following the surgical exposure. If these criteria were carried out he had yet to see a canine in the palate which would not come down without mechanical traction.

Mr. Watkin said he appreciated the paper very much, but Mr. Hartley had not been dealing with treatment but diagnosis and he agreed with everything he had said.

Mr. Ballard said he agreed with all that Mr. Hartley had said and in particular with the fact that he said how difficult it was to assess the position of the canine from the intra-oral films. He said that at the Eastman Dental Hospital they had sought another way of assessing canine position, and they now took as routine a lateral skull picture, and a P–A, not necessarily in a cephalostat. He showed some slides to illustrate his point.

Mr. Norman Gray said that Mr. Hartley had classified and presented these cases in a very clear way. With regard to the problem of the X-ray procedure he liked to take an occlusal picture vertically through the long axis of the incisors, which entailed with the ordinary X-ray machine a tremendous exposure of at least 16 seconds. He thought this was a good way of demonstrating the position of the canine relative to the incisors.

With regard to the actual operation, he wanted to emphasize the necessity of wide exposure of the crown of the unerupted tooth. The surgical pack should be applied under pressure opposite the side towards which you wanted the buried tooth to move, thus encouraging the tooth to move in the right direction; when the pack is replaced the same thing repeated will often greatly facilitate eruption in the desired direction.

Mr. Chapman said he would like to raise one point that had worried him a number of times and that was the position of the apex of a more or less horizontal upper canine relative to the premolars. He found this an exceedingly difficult thing to diagnose from X rays: could Mr. Hartley give any help on this point?

Mr. Walpole Day said that it was primarily a paper of clinical assessment. He hoped one day one would be given on treatment. There was one point that had not been touched on at all and that was the question of vitality of the unerupted tooth. During the war a lot of work was done in Birmingham on the effects of cements on the dental pulp. He had to provide the teeth which were used, most of which were $\frac{4}{4}$ which were destined to be extracted for orthodontic treatment and $\frac{5}{5}$ which had erupted into the palate. Professor Manley found that the canines and premolars in the palate that were given him were useless because in the majority of cases they showed reticular atrophy of the pulp. He said it had been suggested that where a tooth is delayed, the delay caused atrophy of the pulp. He wanted to know whether Mr. Hartley had had any experience of this in unerupted canines in a child of, say, 13 or 14. He said that he had experienced this in central incisors that had been delayed and had observed differences in the colour between them where one was delayed. He would like to hear Mr. Hartley's observations on this point.

Mr. Pringle said that he thought the unerupted canine was one of the most difficult problems that the orthodontist came up against. He said that he still saw a number of unsuccessful cases where rather heroic treatment had been attempted to bring canines into the arch. He said that as one got older one got less heroic. He thought Mr. Hartley had sounded a note of warning.

Mr. Hartley said he entirely agreed with Mr. Pringle. One of the intentions of the paper was to discourage people from being too heroic.

Replying to Mr. Kettle he agreed that the tilt of the upper lateral could be an important diagnostic feature. He omitted that from his paper because he thought that there were others which were more commonly found. He felt that the radiographs could not fail to give the information required if they were taken from the right directions. Mr. Kettle had disagreed with this, saying that it was difficult to assess the labiolingual relation of the canine to the lateral incisor by means of X ray. The occlusal film exposed with the X-ray tube in the long axis of the upper incisors specifically overcame this difficulty. He had attempted to lay stress upon the simpler types of case because they were the ones for which we were able to do most. In the matter of zinc oxide packs which Mr. Kettle mentioned, he had deliberately omitted reference to this detail of treatment, because by "surgical exposure" he implied the use of any such technique which gave adequate exposure of the canine crown and maintained the opening during healing.

Mr. Hovell had remarked particularly about treatment, but he (Hartley) had purposely excluded from his paper considerations of treatment except in terms of broad principles. Had he included detailed treatment he would certainly have agreed with Mr. Hovell. He would like to add a word about mechanical traction to which Mr. Hovell had referred. Mechanical traction was not primarily to pull the canine down but to tilt it away from other teeth so that it would then have an unobstructed path of eruption and could be left to follow that path to a greater or lesser extent.

He thanked Mr. Watkin for his remarks.

Mr. Ballard had raised the point of taking one's own X rays. Certainly positioning of the tube and film was extremely important in this particular type of case. He thought that the choice of intra-oral or extra-oral films depended on one's personal preference. The use of postero-anterior and true lateral radiographs to supplement the intra-oral films described was mentioned in current textbooks.*

Mr. Gray had mentioned the subject of classification. He (Hartley) was not really trying to suggest a new classification for unerupted canines—Adamson had already presented quite a good one.† He had covered Mr. Gray's point about the occlusal picture taken through the long axes of the upper incisors. He thanked Mr. Gray for his helpful comments on the surgery required and said there were a number of techniques which had been advocated.

Mr. Chapman had spoken of the relation of the apex of the canine to the premolars. In a favourable case the apex of the canine would be in the line of the arch buccolingually as seen on the occlusal film, and well above the level of the premolar apices on the periapical film. In the case he showed as having a hopeless prognosis with the canine lying horizontally and crossing from buccal to lingual of the arch, its apex lay buccally to the root of the premolar and the crown lingually to the central and lateral incisors.

He thanked Mr. Walpole Day for bringing his attention to the observations of Professor Manley on reticular atrophy of the pulp in cases of unerupted teeth. Unfortunately he had no personal experience of this.

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† Adamson, K. T. (1952), *Dent. J. Aust.*, **24**, 143.

A CASE OF MARKED LOCALIZED GINGIVAL RECESSION*

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ATROPHY is an acquired decrease in size of a portion of the body, of an organ, of tissues, or of individual cells (Anderson, 1949). Periodontal atrophy is often characterized by gingival recession, there being a concomitant loss of alveolar bone and exposure of cementum. The deeper tissues of the periodontium can also be affected by atrophic changes, as in disuse atrophy, without the characteristic recession of the gingiva necessarily occurring. Also the condition which is now recognized as periodontosis was first described by Gottlieb (1920) as "diffuse atrophy of alveolar bone".

Fig. 1.—Marked gingival recession on the buccal aspect of $\overline{6}|$.

CASE HISTORY

An Indian male, aged 45, was referred because there was an unusual degree of recession around a very loose $\overline{6}|$.

The loosening of this tooth had only occurred over the last three or four years subsequent to the extraction of $\frac{76|6}{}$ four years previously. The $|\overline{7}$ had also been extracted at some time prior to this, but it was difficult to ascertain why any of these teeth had been removed. As far as the patient knew, all his brothers and sisters had their own teeth. Nothing of significance was ascertained from the medical history.

Examination showed gingival recession—nearly to the apices of both roots of $\overline{6}|$ on the buccal aspect (*Fig.* 1), whilst lingually it was just below the cemento-enamel junction. The tooth was very loose and did not respond to vitality tests using ethyl chloride and gutta-percha. There was a slight collection of food debris and soft supragingival calculus in the stagnation areas between the exposed roots, and the adjacent gingiva showed signs of inflammation.

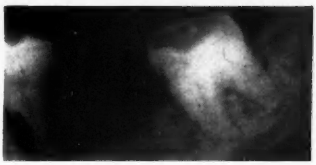

Fig. 2.—Radiograph showing considerable bone loss in the edentulous areas $\frac{76|6}{|7}$.

Besides the recession around $\overline{6}|$, there was considerable recession mesially, lingually, and bucally around $|\overline{7}$, and to a lesser extent distally to $|\overline{6}$. Elsewhere there was slight recession around the buccal aspects of the incisors and premolars. There was loss of contact between $|\overline{45}$ with a 10-mm. pocket distal to $|\overline{4}$: otherwise there was no pocketing more than 2–3 mm. The

* A Casual Communication to the British Society of Periodontology at the meeting held in Edinburgh, March 3, 1956.

$\overline{|7}$ was the only tooth other than $\overline{6|}$ which was markedly mobile.

The radiographs showed very marked bone loss in the edentulous areas $\frac{76|6}{|7}$ (*Fig.* 2), as well as around $\frac{|7}{6|}$ and distal to both $\overline{|4}$ and $\overline{|6}$ (*Fig.* 3). The pattern of bone loss around $\overline{6|6}$ was interesting in that the distal roots of both teeth had been similarly affected, the right side more than the left. Around the mesial roots, $\overline{6|}$ had very little bone support other than on the lingual aspect, and yet around $\overline{|6}$ there was well-marked interdental and interseptal bone (*Fig.* 3). Elsewhere the bone was of a normal pattern (*Fig.* 4).

The anteroposterior occlusal relationship was normal and the form and degree of attrition showed that the patient had balanced lateral excursions.

DISCUSSION AND CONCLUSIONS

The aetiology of such marked localized gingival recession as occurred in the $\overline{6|}$ area is difficult to evaluate. The pattern of tooth loss and bone destruction in the molar regions is suggestive of the degenerative condition of periodontosis. The marked gingival recession around $\overline{6|}$ and to very nearly the same extent around $\overline{|7}$ may in part be due to disuse, as both teeth are not in function, whereas the $\overline{|6}$ is receiving slight occlusal function on its

Fig. 3.—The radiograph shows the bone loss around $\frac{|7}{6|46}$. Note the interseptal and interradicular bone around $\overline{|6}$.

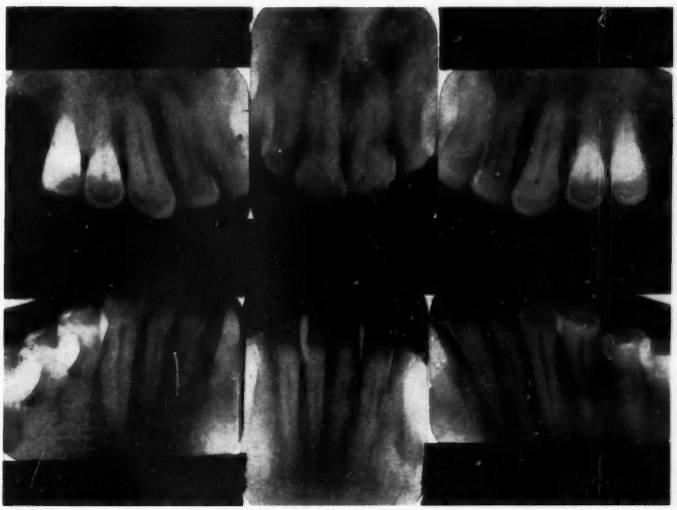

Fig. 4.—Radiograph showing the normal pattern of bone around the other teeth.

mesial aspect from $\underline{|5}$ (*Fig.* 5, A, B). It is interesting to speculate on the relationship between the minimum degree of function necessary to stimulate the periodontal tissues to maintain health, and the speed and degree of atrophy when there is no function. Besides these factors there is the unusual and very marked degree of bone loss in the edentulous areas where the teeth have only been lost for a short period of time, as well as around $\frac{7}{6}$. This combination of marked gingival recession and associated alveolar destruction would appear to be unusual. Is this therefore a case of disuse atrophy and periodontosis combined?

A B

Fig. 5.—A, Models in centric occlusion to show that $\overline{6}|$ is not in function; B, To show that the mesial aspect of $\overline{6}|$ is receiving function from $\underline{|5}$.

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BOOK REVIEW

A COMPLETE FIXED BRIDGE PROCEDURE. By DAVID H. COELHO, A.B., D.D.S., Associate Professor, New York University College of Dentistry; and JULIAN M. RIESER, A.B., D.D.S., Assistant Professor, New York University, College of Dentistry. 9 × 6 in. Pp. 140 + viii, with 157 illustrations. 1955. New York: University Press. $5.50.

THIS small book deals admirably with one specific technique for bridge making. The procedure for a simple bridge is given faithfully and fully, basing the treatment on full crowns or three-quarter crowns with the pontic between the abutments. Each step from the initial inspection and study models to the final fitting through all the various stages is discussed and illustrated. It will undoubtedly be a useful book to students and teachers of advanced operative procedures, but it does tend to oversimplify many of the difficulties that can be met with in bridgework. It does not, however, claim to be a full text-book on bridgework and treats of no variations in techniques. It is unfortunate that a list of references is not included, which would improve the book and make a wider appeal to postgraduate students. The book is well produced, although some of the illustrations are of little value as are the manufacturers' numbers on instruments. Despite the fact that the procedure outlined may give rise to argument, the book will be welcomed by students and practitioners for its simplicity and clear writing. Bridgework can only be learnt by experience, but this will serve as a good basis and a guide to good procedure.

N. L. W.

THE CLINICAL ASPECTS AND PHYSIOLOGICAL MECHANISM OF ABNORMAL PATHS OF CLOSURE*

By **R. J. G. GREWCOCK** and **C. F. BALLARD**

PART II

(C. F. Ballard)

IT is not the purpose of Part II of this paper to discuss the aetiological factors which produce the abnormal occlusal relationships. It is obvious that the cases that have been described are similar to some of those everyday problems in orthodontic practice.

The significant facts brought out in Part I of this paper are:—

1. That abnormal contact relationship of the teeth can produce abnormal paths of closure.

2. When the abnormal path of closure results in a significant distal displacement of the condyle as judged from true rest position, then "joint disturbances" may result.

3. Individuals with abnormal paths of closure do not make the abnormal occlusal contact in ordinary masticatory movements but avoid them subconsciously (so-called "habit movement"—*vide infra*).

4. The abnormal contact is made in slow closure from true rest position and perhaps in idle movements night and day. These contacts produce the typical facets.

5. Remove the abnormal contacts and the individual rapidly reverts to a normal path of closure and "forgets" the "habit movement".

6. As a rule the individual is never conscious of the abnormal contact in spite of the fact that the resultant displacement of the mandible may be accompanied by severe pain.

7. Abnormal paths of closure are frequently associated with some degree of overclosure or excessive inter-occlusal clearance.

These facts cannot be explained on the basis that the mandibular path of closure is abnormal as a result of the abnormal occlusal contacts producing a sliding movement.

It is the purpose of this part of the paper to suggest the physiological mechanisms involved in abnormal paths of closure in the light of research work that has been done in the past and is in progress at the moment.

One of us has previously suggested that the abnormal path of closure may be a reflex mechanism (Ballard, 1951). It is suggested that the abnormal contacts cause abnormal stresses in the periodontal membrane; these produce afferent impulses which reflexly alter the neuromotor mechanism of closure to avoid this contact if the remainder of the occlusion permits it.

Fig. 1 represents diagrammatically the abnormal contact and resulting movements of the mandible associated with a Class II, division 2 (Angle), incisor relationship. The important feature in such cases is the high angle between the long axis of upper and lower incisors, and the high angle between the latter and the lingual surface of the former. One of us (Ballard, 1948) has previously pointed out that normal incisal occlusion is a definite contact with long axis of lower incisors making an angle of about 115° with the lingual surface of the upper incisors.

Clinically, in such occlusal relationships with distal displacement the following is invariably observed (*see Fig.* 1):—

1. From the physiological rest position the mandible moves through (1) a normal path of closure until the lower incisors make an oblique contact with the upper incisors.

2. Facets are seen at this contact position.

3. The mandible then moves upwards and backwards (2) away from this contact until the cheek teeth occlude and the incisal tips

* Reprinted from the 1954 Transactions of the European Orthodontic Society.

of the lower incisors are either further up the lingual surfaces of the upper incisors or at the gingival margin.

4. This occlusal position is an overclosure.

5. If the patient is asked to close from a more open position than the physiological rest position then the abnormal contact as previously described is not made, but the "habit movement" (3) is used.

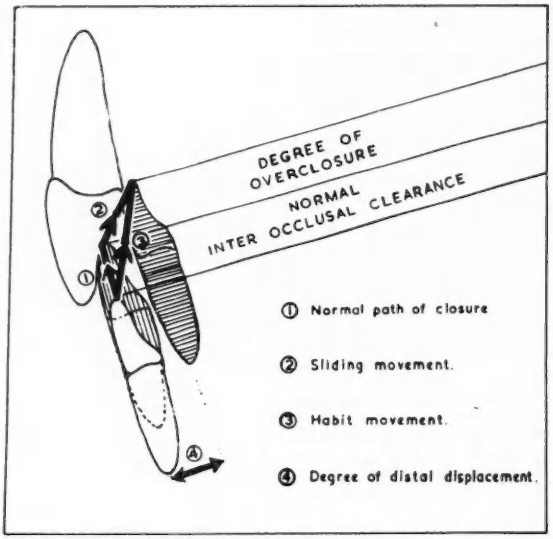

Fig. 1.—Diagrammatic representation of the mechanism of abnormal path of closure induced by a Class II, div. 2 (Angle), incisor relationship.

The author suggests that the contact made in closing from rest position is an abnormal one in terms of the axial inclination of the teeth and nerve endings in the periodontal membrane, and that afferent stimuli go out from the nerve endings in the periodontal membrane which alters the pattern of muscle activity performing the closure, so that the mandible is taken away from this abnormal contact.

Let us now examine the experimental evidence which supports this view. As long ago as 1917 Sherrington showed certain interesting reflex behaviours in the decerebrate preparation. It was noted that all anti-gravity muscles went into steady reflex postural activity. This maintained the jaw in a closed posture. He then showed that tapping the incisor teeth or the gum around the incisor teeth, or the roof of the mouth behind the upper incisors, produced a reflex jaw opening which was quickly followed by a return to the closed position. The other interesting thing that he showed was that reflex closing of the jaw accompanied reflex swallowing which was readily obtained by putting fluid on the dorsum of the tongue near the tip.

D. Stewart (1927) investigated the pressure response of the teeth in the human subject from two aspects. One was the minimal pressure required for a response, and the second was the ability to localize. The investigation was carried out on incisors and canines in a group of medical students. From the point of view of the pressure required it was found that this fell between 7 and 50 g./mm.^{2} on 260 students, on 195 of which it was between 7 and 21 g./mm.^{2}. He said that the amount of pressure required to obtain a response was so small that it is difficult to believe that this pressure would be sufficient to cause any movement of the teeth. He also found that there was a very sensitive ability to localize the pressure

applied to these teeth, and thought that it was such that there must be something more than purely mechanical movement brought into play. Pfaffman in 1939 investigated the discharge of nerve impulse resulting from the application of pressures in the nature of 0·5 to 3 g. applied to the teeth of cats. He confirmed the work of others that the stimulus was almost certainly the result of the tooth movement stimulating the nerve endings in the periodontal membrane.

Orban (1953) says that there are three types of nerve ending in the periodontal membrane:—

1. "Knob-like endings." These are usually nearer the bone than the cementum and are very like the pressure receptors described in physiology text-books.

2. "Loops or rings round bundles of the principal fibres." These may be similar to the stretch receptors in tendons and muscle.

3. "Free endings branching from the main axons." He says that most of the nerve endings are receptors for proprioceptive stimuli.

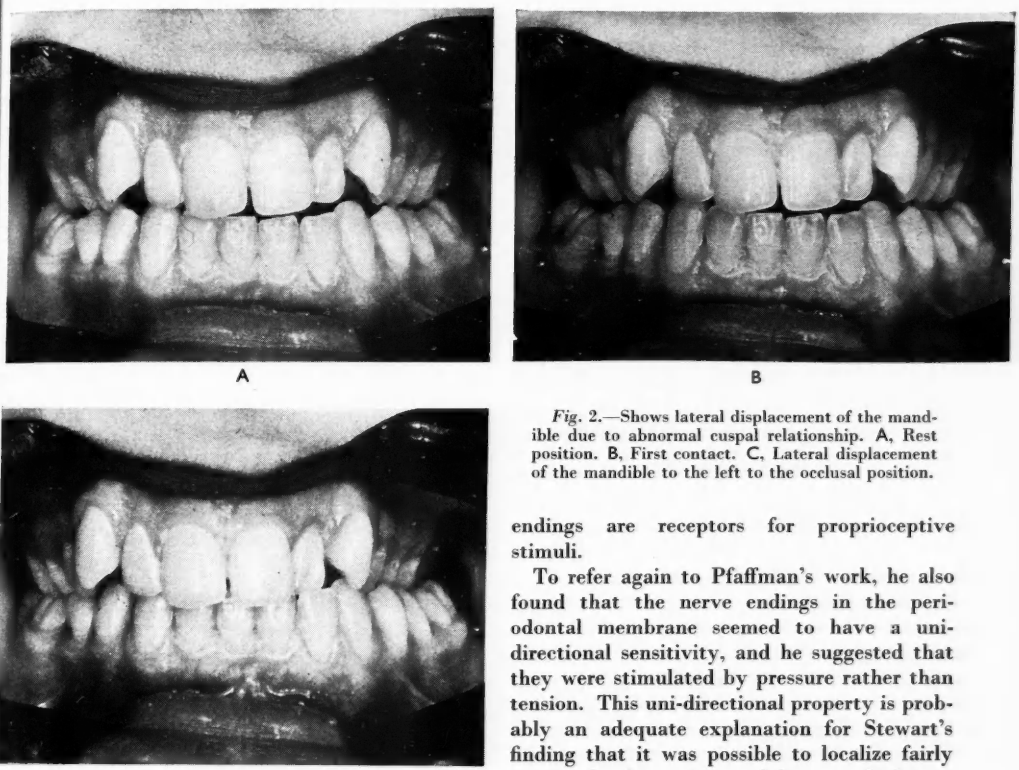

Fig. 2.—Shows lateral displacement of the mandible due to abnormal cuspal relationship. A, Rest position. B, First contact. C, Lateral displacement of the mandible to the left to the occlusal position.

To refer again to Pfaffman's work, he also found that the nerve endings in the periodontal membrane seemed to have a uni-directional sensitivity, and he suggested that they were stimulated by pressure rather than tension. This uni-directional property is probably an adequate explanation for Stewart's finding that it was possible to localize fairly accurately the position of force applied to a tooth. Further, he points out that extreme development of this pressure sensitivity plus the reflex mechanism as demonstrated by Sherrington probably controls the masticatory pattern. Bradlaw (1935) described the nerve supply of the supporting structures of the teeth and suggested that the anastomosis seen "may be a mechanism for the co-ordination and control of the occlusion in the act of mastication".

It is suggested, then, that the habit movement is a conditioned reflex induced by afferent stimuli arising from nerve endings in

the periodontal membrane which are stimulated by the abnormal contact of the teeth. As a conditioned reflex requires continual reinforcement it is likely that in idle movements of the mouth the teeth are frequently making this abnormal contact, hence the facets.

Now, from the point of view of the efferent side of the reflex mechanism we know from the electromyography studies of Moyers (1949, 1950) and others that in normal closure from rest into occlusion there is as a rule symmetrical activity of the temporalis and masseter muscles. We also know from Moyers' work that the posterior part of the temporal muscles are active and probably the main mechanism in forced retraction of the mandible. In the cases, therefore, in which there is demonstrated a distal displacement of the one condyle associated with pain, it is likely that this is produced by reflex activity of the posterior temporal unilaterally (*Fig.* 2 A). This individual had a narrow maxillary arch in which the movement from physiological rest position to first contact (*Fig.* 2 B) produced a very awkward cuspal relationship of the cheek teeth. From this she swung to the left (*Fig.* 2 C) to produce a complete lingual occlusion of the left maxillary buccal segment. The electromyograph shows early activity of the posterior temporal on the left side, and *Fig.* 3 shows the distal displacement of the left condyle. The electromyographic record was taken in Professor Slome's department at the Royal College of Surgeons by Mr. Greenfield, and the findings are quoted by permission. If the distal displacement is bilateral, then there would probably be bilateral hyperactivity of the posterior parts of the temporalis muscles.

It is a common finding that these abnormal paths of closure are associated with an excessive interocclusal clearance or overclosure (*see Fig.* 1). A possible explanation of this is as follows: if it is accepted that the occlusal level of the cheek teeth is the result of a balance between the inherent factor of vertical development of dento-alveolar structures and the algebraic sum of occlusal forces (again, a reflex mechanism producing relaxation of the muscles of closure at moment of contact is probably involved), then the excess freeway space associated with the many abnormal paths of closure can be the result of the vertical component of the abnormal muscle activity balancing the

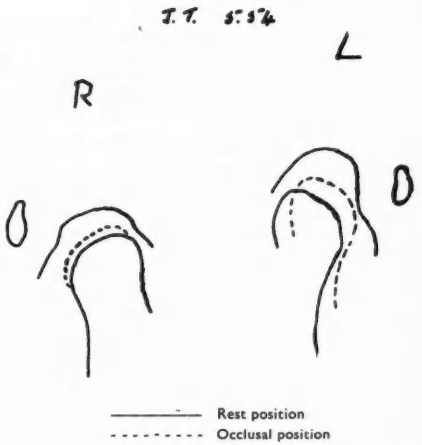

Fig. 3.—Shows distal displacement of the condyle on the left (case illustrated in *Fig.* 2).

inherent vertical development of dento-alveolar structures at an overclosed position in relation to the physiological rest position.

Another clinical finding is that abnormal contacts with marked facets, when associated with abnormal paths of closure, are rarely associated with pathology in the periodontal membrane or surrounding bone. It is likely that the explanation for this is that the pressure required to produce the afferent stimuli which initiate the avoiding action is below that necessary to stimulate absorption, thickening of the periodontal membrane, and tooth movement. Stewart's investigation showed that in human beings the average pressure was about 20 g./mm.^{2} to produce a stimulus in the nerve. As the tooth is a solid structure, the area over which the force is applied appears to be an insignificant factor, but 20 g. applied intermittently in idle movement only is probably not sufficient stimulus to physiological tooth movement. Pfaffman found that in the cat the pressure required to produce a

nerve impulse was between 2 and 5 g. as already mentioned. If this conditioned reflex is initiated by a stimulus of which the individual is not conscious, then it is an instinctive movement or innate behaviour. (Endogenous movement—Lorenz, 1950.) The mechanism must be inherited and it would be interesting to speculate on its importance in the process of evolution.

Fig. 4.—Lateral radiograph of a treated Class III. Note loss of apices of upper incisors.

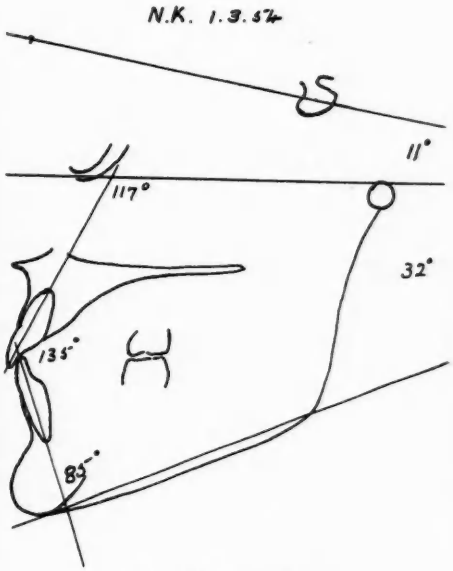

Fig. 5.—Tracing of *Fig.* 4.

If the physiological mechanism as described is really present, then it is interesting to speculate on its relationship to pathological conditions so frequently seen in the supporting structures of the teeth in association with abnormal contacts without displacement. Why, for instance, when one sees an obvious traumatic occlusal relationship, has not the mandibular path of closure taken avoiding action? It is likely that there are limits to this reflex avoiding action, and that in many cases it is not possible for reflex movement to avoid the contact. For instance, *Figs.* 4 and 5 show a treated Class III occlusion in which the upper incisors had been pushed over the lower incisors so that the incisor overbite was the factor in holding them forward against lip action. The patient reported that he could only close his back teeth if he applied sufficient pressure to push his incisor teeth forward out of the way. This was obviously the result of the position of balance at rest, that is, between the lips and tongue, not being the same as that in the occlusal position. The result was, unfortunately, excessive absorption of the roots of the teeth, and permanent thickening of the periodontal membrane. If one looks at the lateral radiograph one can very readily visualize from the angle of the lingual surface of the upper incisor to the long axis of the lower incisor, and the path of closure, that sufficient distal displacement to avoid this awkward relationship is impossible. The anatomy of the temporomandibular joint is such that a displacement of more than 1–2 mm. is not possible.

There is, however, another aspect to this question of traumatic occlusion. We know from Pfaffman's work that the nerve endings

in the periodontal membrane are probably unidirectional receptors. It may be, therefore, that in this type and other cases, traumatic occlusion results from the stimuli not being applied in the correct direction to induce the avoiding pattern of behaviour.

So far, from our arguments, then, we can say that the position of equilibrium of the teeth in soft tissue behaviour in the rest position must be the same as the position of equilibrium resulting from cuspal engagement when the mandible moves from rest into true centric. If this is not so, then a periodontal condition might result, unless there is an abnormal path of closure to adjust the occlusal position so that no undue stresses are applied to the teeth in the eccentric occlusal position.

Finally, there is the great possibility that in many cases of abnormal contact displacement is not possible because of the interdigitation of the remainder of the dentition. There is a school of thought which believes that many cases of traumatic occlusion are due to bruxism, idle grinding or empty mouth movements (Beyron, 1954). Again, if our idea is correct that there is this reflex between proprioceptive receptors in the periodontal membrane and the patterns of movement of the mandible, it may be that certain abnormal occlusal contacts will induce bruxism as a conditioned reflex in an attempt to wear the teeth away so that the occlusion is adapted to the innate neuromuscular patterns. There is experimental evidence to show that the incisor teeth of the rodent grow at a constant physiological rate quite unrelated to normal wear, and that the animal grinds them together in order to maintain the functional occlusal level. It seems to me that this mechanism must be a reflex one, the mechanism for it to be established being present in the species as an inherited character.

Our final speculation is on the aetiology of the cause of pain. There is still much discussion on this subject, but the generally accepted idea is that it is somehow associated with a distal displacement of the mandible. It is a common finding, however, that a forward displacement of the mandible associated with many Class III edge-to-edge incisor occlusions from rest to the initial contact also present so-called "joint symptoms". It may be, therefore, that the pain experienced in all these cases is not truly the result of pathology in the joint, but might be in some way related to the reflex mechanism disturbing the normal pattern of movement of the musculature. Many orthopædic problems arise as the result of muscle imbalance.

To summarize: an attempt has been made to show that a better knowledge of the anatomy and physiology of the orofacial mechanism might supply the answer to many orthodontic and periodontal problems.

I wish to thank Mr. J. F. Reading, B.D.S., F.D.S. R.C.S., of the Orthodontic Department, who drew *Fig.* 1, and Mr. D. R. McDougall of the Photographic Department, Institute of Dental Surgery, Eastman Dental Hospital, for their help in producing the illustrations.

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Production of Hyaluronidase and Beta-Glucuronidase by Viridans Streptococci Isolated from Gingival Crevices

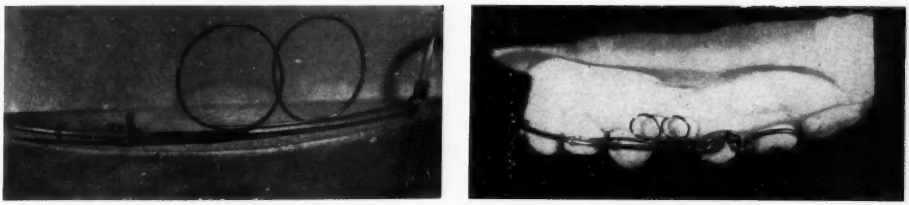
Examination of strains of *Strep. mitis* and *Strep. salivarius* isolated from the gingival crevices of 31 adults, some of whom had clinical manifestations of marginal gingivitis, revealed a significantly higher percentage of enzyme-producing organisms in the group having gingivitis.

The hyaluronidase was found to be extracellular, whereas the beta-glucuronidase was endocellular.—SCHULTZ-HAUDT, S. D., and SCHERP, H. W. (1955), *J. dent. Res.*, **34**, 924.

AUXILIARY SPRINGS FOR RETRACTION OF CANINES*

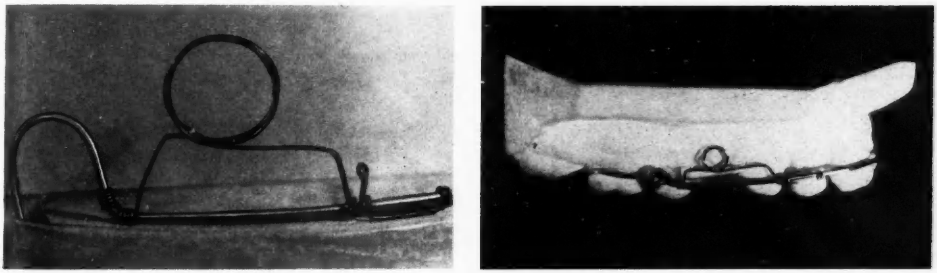
By **E. K. BREAKSPEAR**, L.D.S. R.C.S. (Eng.), D.Orth. R.C.S.

THE four springs demonstrated have been fully described elsewhere by Rix (1938) and Breakspear (1949). They are normally made in 0·3-mm. stainless-steel wire, wound on a 0·8-mm. bow. The aim of the series was to produce a spring with a gentle continuous action, but sufficiently resistant to displacing forces in the mouth, capable of easy change or replacement, and requiring no soldering or welding. In each case the first two sets of coils are purely for attachment, the active portion of the spring lying beyond the second set. Working arm and stabilizers slide freely on the main bow. The springs are usually made at the chairside, the patient having first become accustomed to wearing the appliance without them.



A B

Fig. 1.—Canine retractor No. 1. A, Enlarged model; B, As used in the mouth.



A B

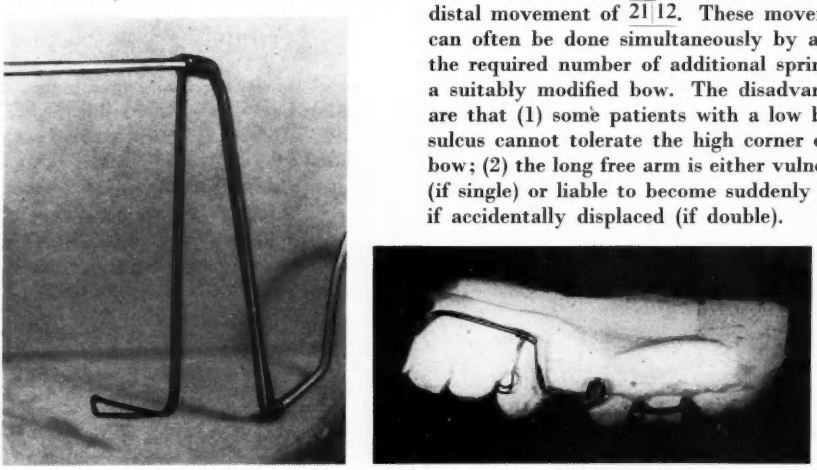
Fig. 2.—Canine retractor No. 2. A, Enlarged model; B, As used in the mouth.

The following points were made in discussion. *Canine retractor No.* 1 (*Figs.* 1 A, B), though effective, suffered from comparative harshness, vulnerability, and a tendency to distort under tension. It is now superseded by *canine retractor No.* 2 (*Fig.* 2 A, B), incorporating a near-vertical element which makes for smoother and more precise action, the coils being smaller and more compact. (*N.B.*: It will be observed that the seating of the active arm on the tooth illustrated is not ideal. This is discussed later.) As a "general purpose" spring it is particularly useful for retraction of first premolars followed by canines, or for cases where the incisor overlap is to be decreased and a labial bow is included in the appliance. The spring can readily be re-activated when necessary by flattening one or more arcs of the main coil.

Its disadvantages are that: (1) Older patients dislike a horizontal labial bow across

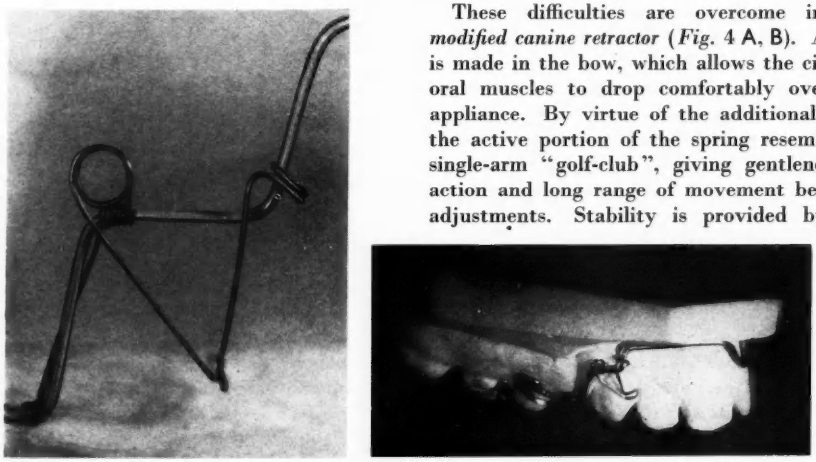
* Based on a demonstration given at the Country Meeting of the British Society for the Study of Orthodontics, at Sheffield, on May 7, 1955.

the incisors; (2) In the case of incompletely erupted canines (as in *Fig.* 2 B) it is difficult to place correctly on the tooth. In such cases it is advantageous to use the high labial bow with the "*golf-club*" *spring* (*Fig.* 3 A, B) which can be set at any desired level, and can be adapted to move the tooth in any direction in the horizontal plane.



A B

Fig. 3.—"Golf-club" spring. A, Enlarged model; B, As used in the mouth.



A B

Fig. 4.—Modified canine retractor. A, Enlarged model; B, As used in the mouth.

The "golf-club" spring is especially indicated in older patients with crowded incisors, where retraction of $\frac{3}{3}$ is to be followed by distal movement of $\frac{21}{12}$. These movements can often be done simultaneously by adding the required number of additional springs to a suitably modified bow. The disadvantages are that (1) some patients with a low buccal sulcus cannot tolerate the high corner of the bow; (2) the long free arm is either vulnerable (if single) or liable to become suddenly harsh if accidentally displaced (if double).

These difficulties are overcome in the *modified canine retractor* (*Fig.* 4 A, B). A step is made in the bow, which allows the circumoral muscles to drop comfortably over the appliance. By virtue of the additional coils, the active portion of the spring resembles a single-arm "golf-club", giving gentleness of action and long range of movement between adjustments. Stability is provided by the compact construction, which reduces the displacing forces, and the oval stabilizing loop, with its supporting arm. It is especially suitable for patients who are away at boarding school.

As demonstrated, its locus of movement is a downwards and backwards curve, in itself an undesirable characteristic; when the tooth to be moved is incompletely erupted, however, this mode of action becomes an advantage. (Compare the seating of the working arm with that of canine retractor No. 2 in the same case —*Figs.* 2 B, 4 B). This effect can be overcome either by periodical adjustment to the working arm, or by placing the coil more directly over the arm, producing a pendulum-like movement: this reduces space available for attachment of an apron spring later if required.

Canine retractor No. 1 is now rarely used, but the three others each have an application in everyday practice, some being particularly indicated in certain types of case. Many variations are possible for individual requirements.

I wish to express my thanks to Mr. R. Ernest Rix for permission to demonstrate canine retractors No. 1 and No. 2 and the "golf-club" spring, which are of his devising. Mr. Rix has pointed out that in such a case as shown in *Fig.* 2 B he would keep the horizontal portion of the spring very short, and would obtain horizontal extension by means of a sliding runner carrying the working arm at the far end. He also prefers a single to a double coil, for ease of adjustment. My thanks are also due to Dr. M. C. Manifold for the preparation of the photographs.

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LETTERS TO THE EDITOR

March 2, 1956.

Dear Sir,

Your plea (Editorial, *The Dental Practitioner*, February, 1956) for a dental school to be established in Nigeria is one that will be applauded by all who have the interests of Britain's Overseas Territories at heart. Although it must be admitted that training in general medicine is the first requirement among the healing arts for primitive and backward areas, too often those responsible for control of centres of higher learning (and still oftener those responsible for loosening the purse-strings) believe that no more is required so long as a few doctors and nurses are trained each year. Pressure upon authority to set up dental schools often comes only from qualified dentists, and as always in the absence of a dental school there is a grave shortage of such dentists in the territory concerned.

In the British Crown Colony of Hong Kong (population 2·5 millions), although there is an excellent medical school with a long and honourable history, whose graduates are registrable with the General Medical Council, there is no dental school. The Hong Kong Dental Society, representing the sixty-odd qualified dental practitioners in the Colony, in 1953 made representations to the Government of Hong Kong that a dental school should be established in order to avoid a very serious shortage of dentists in the near future. Plans were submitted with recommendations in some detail in respect of staffing and general control by the University of Hong Kong. Although Government was in favour of establishing a scheme whereby a regular supply of well-qualified dental surgeons would be assured for the Colony, the high cost of setting up and running a school unfortunately proved a deterrent. An alternative scheme was approved whereby Hong Kong Government was to award scholarships annually to suitable men and women for their joint training in the Universities of Hong Kong and Malaya. The first dental scholarships were awarded in 1954, and it is the intention to award nine each year. The scholarships are of the value of approximately half the cost of a student's training and living expenses throughout the five-year course, plus return fare to Singapore and a substantial grant towards the cost of books and instruments. The student first enters Hong Kong University, where he carries out

his Preliminary Science studies, sitting for the Hong Kong University examination in Chemistry, Physics, and Biology after one year's study. Having passed his examination the student proceeds to Singapore, where he enters the Dental School of the University of Malaya for the final four years. The student on accepting a dental scholarship signs an undertaking to return to Hong Kong after qualification, and stay in Hong Kong for at least three years, of which at least one year must be spent in Government service as an Assistant Dental Surgeon. In this way it is hoped that returned dental graduates will have the opportunity of gaining experience in Government clinics and hospitals and will then either join Government service for a career or establish themselves in private practice. This Scholarship scheme, although not as beneficial to Hong Kong as would be the establishment of its own dental school, is nevertheless a good example of how Governments and Universities can co-operate to help forward the cause of dental education.

Yours faithfully,

WALTER C. ALLWRIGHT
Government Dental Specialist,
Hong Kong.

" *Beecholme* ",
New Road,
Rotherfield, Sussex.

March 2, 1956.

Dear Sir,

Your readers may be interested in this unusual case. The patient, an airman aged 19, attended for the extraction of $\underline{|6}$ which was grossly carious. I administered a P.S.D. injection using 2 per cent xylotox and introduced the needle in the usual position just behind the disto-buccal root of $\underline{|7}$. After the needle had entered about 15 mm., I injected, whereupon the patient felt a violent stab of pain. I removed the needle and then infiltrated the rest of the xylotox around the $\underline{|6}$ and $\underline{|4}$, buccally and palatally, the latter tooth also requiring extraction. I then noticed that the whole of the left side of the hard palate had blanched. On further examination I found the whole of the buccal attached gingiva on the left side of the upper jaw, and also an area of skin on the face in the infra-orbital region, were similarly affected. This blanching had occurred from 30 seconds to 1 minute after my first P.S.D. injection. These areas of blanching, particularly the facial one, were clearly delineated but had gone completely after 10 minutes. The patient experienced no further pain apart from the first sudden spasm.

My only suggestion as to the possible cause of this phenomenon is that I injected directly into the sphenopalatine ganglion, thereby knocking out vasodilator fibres to some arteries and causing constriction, with consequent blanching. I should be grateful to hear of any explanation of this phenomenon and interested to hear if other practitioners have ever had similar experiences.

Yours faithfully

H. HALL.

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NATIONAL HEALTH SERVICE NOTES

Replacement of Dental Appliances

E.C.N. 157 (September, 1954) described arrangements introduced to enable patients (or parents), if they so desired, to pay a deposit so that replacement of orthodontic appliances could be proceeded with while the Council was investigating whether the need for replacement arose from carelessness. These arrangements, which were experimental at first, are (with some modification in procedure) to be continued.

The Minister has also at the request of the representatives of the profession decided to bring all other dental appliances within the scope of the new arrangements. E.C.N. 193 sets out the procedure which covers all appliances including orthodontic appliances, and supersedes E.C.N. 157.

ABSTRACTS FROM OTHER JOURNALS

Periodontal Osseous Surgery Osteoplasty and Osteo-ectomy

The author believes that osseous surgery is needed in many cases where the bone morphology is irregular around periodontal pockets, gingivectomy alone being sufficient. Pocket elimination can be achieved in a variety of ways and he believes that osteoplasty or osteo-ectomy are complementary to the existing methods. Osteoplasty is a plastic procedure to recontour the alveolar bone without removing tooth-supporting bone in order to eliminate the pocket and establish a better gingival contour.

The indications for osteoplasty are in deep interproximal pockets around posterior teeth, where the buccal bone often has an irregular and bounted outline—around teeth which are out of alinement—and mesially to tilted mandibular second molars.

Osteo-ectomy is indicated where there are broad interproximal craters in the posterior region—in shallow infrabony pockets where reattachment has failed and occasionally in isolated deep interproximal pocketing.

The operations are carried out by diamond stones, burs, and chisels at the same time as gingivectomy, by means of a modified or full flap operation or without any retraction of a flap at all. The area is covered postoperatively by tinfoil and then a pack.

The author contends that many failures in soft-tissue surgery are due to the fact that the underlying bone morphology has not been dealt with adequately.—FRIEDMAN, N. (1955), *J. Periodont.*, **26**, 257.

The Healing of Periodontal Wounds in Dogs

The authors conducted two main experiments on six dogs. The first series consisted of damaging the periodontal tissues by elevating a buccal flap of gingivæ and cutting through alveolar bone, periodontal membrane, and cementum with diamond stones, after which the flaps were sutured back, thus trying to eliminate contamination and epithelial ingrowth. Healing occurred along normal lines, the bone trabeculæ following deep excavations of the tooth so that a constant periodontal membrane width was established. Reattachment of periodontal fibres occurred where new cementum was deposited—yet there were areas where no new cementum was formed and hence no reattachment.

In the second series two sets of lesions were made:—

1. A slender knife blade was inserted into the gingival crevice and introduced into the periodontal membrane. Two reactions were observed. After several weeks there were no signs of inflammation and yet epithelial downgrowth from the gingivæ was sometimes observed. After two or three months reattachment occurred through the deposition of new cementum.

2. A round bur was passed through the gingival crevice into the periodontal tissues. After two or three months inflammatory signs were reduced and reattachment took place.

The authors conclude that the question of reattachment being a race between epithelial proliferation on the one hand and the laying down of cementum on the other is hardly valid because reattachment may be absent for several months without any epithelial downgrowth.—JANSEN, M. T., COPPES, L., and VERDENEUS, H. H. W. (1955), *J. Periodont.*, **26**, 292.

Observations of the Permeability of the Human Calcified Dental Tissues to Penicillin

Enamel and intact cementum have been shown to be impermeable to the passage of penicillin by a series of experiments conducted by the investigators. The contrary results reported by Shuttleworth were apparently due to the unreliable nature of the seal obtained with waxes or cement. In this investigation rubber connexions under pressure were used to achieve a perfect seal. The teeth used were all single-rooted. Immediately following extraction, the crowns and apices

were removed and the ends of the root pushed into sterile rubber tubes. These were tightly ligated to the tooth. A closed glass tube was then inserted into the rubber tubing at one end and an open tube into the other rubber tube. Penicillin was carefully introduced into the open tube, taking care to avoid contamination of the outside. This tube was then heat-sealed. The tube was then placed in a Petri dish and covered with melted nutrient agar. After placing in a refrigerator for a period up to 72 hours to allow diffusion of the penicillin, the plates were inoculated with a Standard Oxford Staphylococcus culture and incubated. By a similar method the permeability of enamel was tested. In no case was there a zone of inhibition indicating a passage of penicillin through either cementum or enamel.

It is concluded that the value of penicillin and probably other antibiotics in root-canal therapy is derived from the passage of the drug through the apical canal.—BENNETT, D. T., and MILES, A. E. W. (1955), *J. dent. Res.*, **34**, 553.

Adamantinoma

A brief review is given on the aetiology and pathogenesis of adamantinoma, together with the reference to its important histological and clinical features. The radiological appearances are also discussed. The authors then describe a case which was treated by resection and immediate replacement by a prefabricated allelograft of tantalum and acrylic resin.—HOLDSWORTH, W. G., and ROWE, N. L. (1956), *Brit. J. Surg.*, **43**, 225.

EXAMINATION RESULTS

UNIVERSITY OF LIVERPOOL

March, 1956

The following students have satisfied the examiners:—

Degree of Bachelor of Dental Surgery (*Final Examination, Part II*):—

Atherton, J. D. (with distinction in oral and dental diseases); Bennett, I. C.; Kerr, N. W.; Murray, June P.; Newton, A. V.; Shillaker, M. J.

Licence in Dental Surgery (*Final Examination, Part II*):—

Horowitz, Erika F.; Lidbetter, L. O.; Matson, K.; Monteith, J. H. B.; Paynter, Patricia; Rhodes, Lilian; Richards, J. K.; Tomkins, Jean G.; Young, T. A.

Degree of Bachelor of Dental Surgery (*Second Examination, Part I*):—

Cawley, M. F.; Johnson, K.

Licence in Dental Surgery (*Second Examination, Part I*):—

Barker, H. E.; Birchall, T.; Ditchfield, T. W.; Habibollahi, D.; Harrop, J. W.; Keniry, A. J.; McMahon, B. N. C.; Ogundipe, N. O.; Upson, N.

Degree of Bachelor of Dental Surgery (*Second Examination, Part II* (*c*)):—

Cunliffe, J. J.; Danchin, N.; Llewellyn, R. L. (with distinction); Vega, G. A.

Licence in Dental Surgery (*Second Examination, Part II* (*c*)):—

Connor, V. A.; Hernaes, Ingrid K.; Kent, R. F.; Love, P. S.; Noar, G. A.; Powell, F.; Rader, A.; Smith, H.; Warner, Marie A.; Williams, H. R.; Wookey, C. P.; Woolrich, G. B.

Degree of Bachelor of Dental Surgery (*First Examination* (*c*)):—

Gould, M.; Si, M. B.; Turnbull, M. D.; Vautier, D.

Licence in Dental Surgery (*First Examination*):—

Beach, Annette M. (b); Davies, T. E. (b); Frantzen, J. (a, b, c); Fulton, Linda M. W. (b, c); Hughes, Anne E. T. (a, b); Littler, G. (a, c); Magnusson, Berit H. (a. b, c); Myrer, A. (a, b, c); Quinlan, Ann (a); Towers, J. F. (b, c); Walsh, Elizabeth M.(b); Watson, P. J. (a).

a, Chemistry; b, Physics; c, Biology.

XII INTERNATIONAL DENTAL CONGRESS

THE XII International Dental Congress will take place in Rome, Italy, Sept. 7–14, 1957, under the High Patronage of the President of the Italian Republic, the Hon. Dr. Giovanni Gronchi.

The Italian Prime Minister has agreed to be the Honorary President of the Congress.

The Congress, which is sponsored by the F.D.I., is organized by the Associazione Medici Dentisti Italiani. The purpose of the Congress is to further the progress of the science and art of dentistry and the international relations of the dental profession.

The Congress will take place in the Congress Palace situated in the zone of the E.U.R. (Universal Rome Exhibition), the city park of modern Rome. This palace was designed to house every kind of Congress and the magnificence of its halls and its excellent technical installations make it one of the finest buildings of its kind in Europe to-day.

The ground floors of three other buildings in the vicinity of the Congress Palace will house the various Exhibitions.

Full details may be obtained from Dr. Pio Lalli, Secretary General, Via Boezio 16, Rome.